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Stanley Abramowitz, A. M. Bass, and A. E. Ledford, Jr.

Technical Report
to
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Washington, D.C.

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Preface

A manuscript based upon this report will be submitted for publication in the Letters to the Editor Section of Applied Optics.

A NEW METHOD FOR COOLING PHOTOCONDUCTIVE DETECTORS*

Stanley Abramowitz**, A. M. Bass, and A. E. Ledford, Jr.

The use of cooled photoconductive devices as detectors for the infrared region is widespread. In most of these detectors such as the lead (II) salts, (PbS, PbSe, and PbTe) the signal-to-noise ratio varies inversely as the square root of the area of the detector. Therefore it is advantageous to use as small a detector as possible. Since the photoconductive detectors are often mounted in bulky dewars, it is common practice to redirect as well as to demagnify the image. This avoids vignetting a rather large amount of the beam with the dewar. Most of these methods, such as the use of two ellipsoidal mirrors or Cassegrainian type optics first demagnify the beam and then magnify the beam and bring it to focus of the surface of the photoconductive device. The use of off-axis optics such as off-axis toroidal mirrors, or 90° off-axis ellipsoids often tends to distort the image and make it diffuse

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**National Academy of Sciences-National Research Council Post-doctoral Resezrch Associate at the National Bureau of Standards.

thereby making their use unsuitable for small detectors.

The optical system reported here utilizes an ellipsoidal mirror, placed in a vacuum chamber, which focuses a demagnified image of the exit slit onto a photoconductive detector mounted on a rod in contact with liquid nitrogen, (see Figure 1). The ellipsoid is used on-axis and has a demagnification ratio of about 6 (f_1= 7.19", f_2= 1.34").[1] A 1/4" O.F.H.C. copper rod which is screwed into the bottom of a one-liter spherical stainless steel dewar is used to support the detector. The portion of the rod which projects into the optical path is turned down to 1/8". The detector is mounted with silver conducting paint on a flat milled on the end of the rod. The ellipsoid is mounted within the dewar vacuum space. The dewar, and hence the detector, is fastened to the chamber which contains the mirror through two flanges which are connected by a flexible bellows. The aluminum tube and adaptors for mounting of the dewar and ellipsoid are dip welded and black anodized. Fine adjustment of the detector position is accomplished by means of three 3/8" hexagonal-stock pivot screws attached through the flanges and separated by 120°. In the exit beam of a spectrometer of f/10 aperture about 10% of the beam is vignetted by the 1/8" rod. With instruments employing f/4.5 optics much less of

the beam would be lost. The use of 1/16" rod would improve this figure without significantly altering the rate of cooling of the detector. The rate of temperature drop of the detector after addition of refrigerant may be followed by measuring the increase of its resistance. In this system about 10-15 minutes are required to cool the detector to liquid nitrogen temperature.

The system is separated from the monochromator by a suitable window. A calcium fluoride window may be used for the 1-10 micron region. In this system a 2" oil diffusion pump is adequate for evacuation of the ellipsoid-detector compartment as well as the monochromator (monochromator volume of about 15 liters). A pressure of 10^{-5} mm Hg is readily obtained and a single filling of the dewar (1 liter) will last for more than 24 hours. This arrangement has been used satisfactorily in the 1-4 micron region with a PbS detector.[2]

It should be possible to use other photoconductive and thermocouple detectors in this same arrangement. All that is required is mounting of the detector on a suitable copper rod, and screwing this rod into the bottom of the dewar.

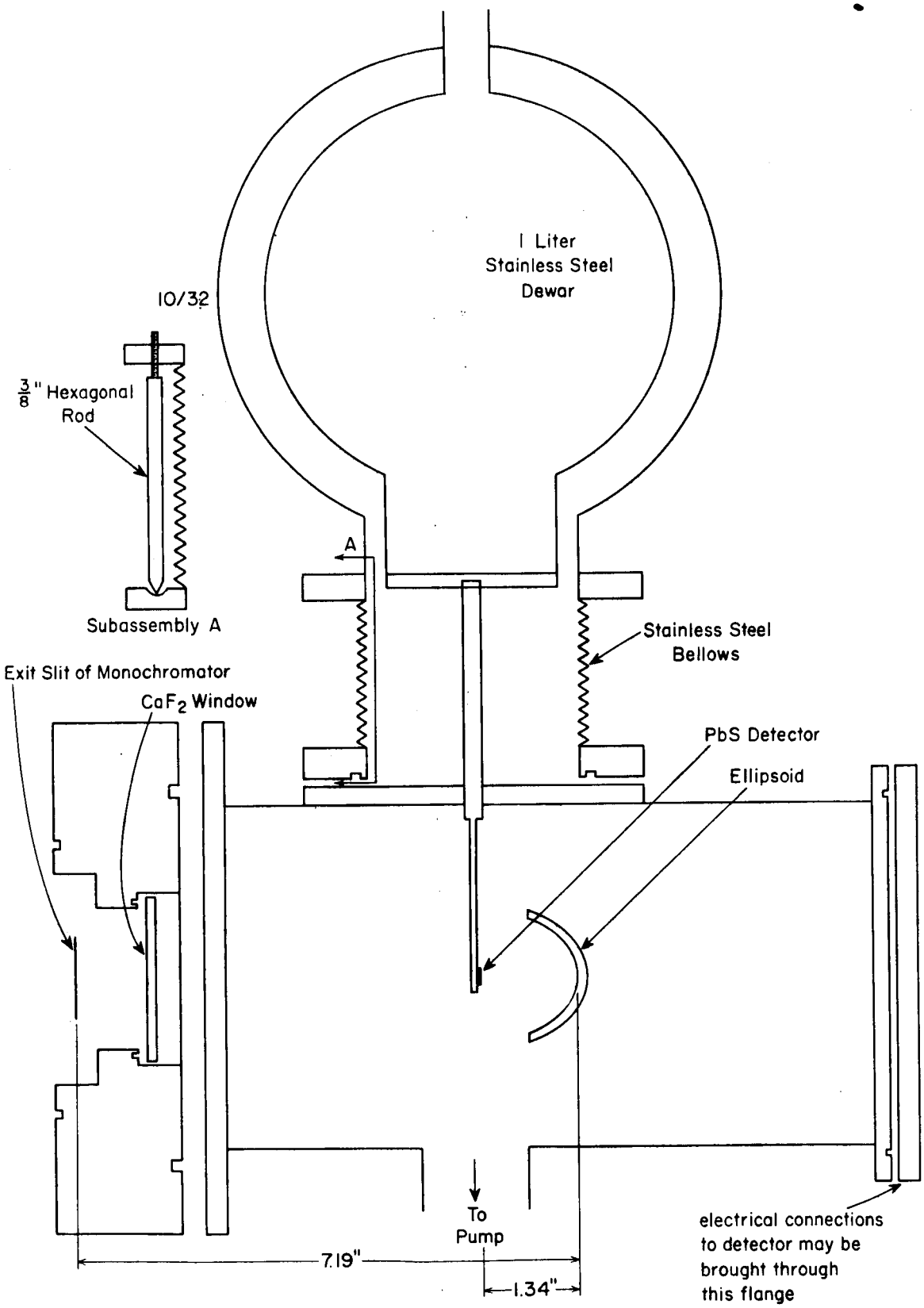
REFERENCES

[1] The ellipsoid and mount are available from the Perkin-Elmer Corporation, Norwalk, Conn.

[2] Eastman-Kodak Ektron Type P-2.

FIGURE CAPTION

Figure 1 - Schematic Diagram of Low Temperature Detector Mount.


1 Liter
Stainless Steel
Dewar
10/32
3/8" Hexagonal
Rod
Subassembly A
A
Stainless Steel
Bellows
Exit Slit of Monochromator
CaF2 Window
PbS Detector
Ellipsoid
To
Pump
7.19"
1.34"
electrical connections
to detector may be
brought through
this flange